[12604/14]

TRANSMITTER HEAD AND SYSTEM FOR CONTACTLESS ENERGY TRANSMISSION

The present invention relates to a transmitter head and a system for contactless energy transmission.

DE 100 53 373 A1 describes a device for contactless energy transmission. In that case, a transmitter head is described which permits inductive energy transmission and has a number of turns per unit length.

DE 44 46 779 C2 and DE 197 35 624 C1 describe a system for contactless energy transmission, in which the path is made up of a stationary neutral conductor, and an aluminum profile as return line. The neutral conductor is surrounded by a U-shaped core of the transmitter head, the core being movable along the neutral conductor. A winding is provided on the U-shaped core. All in all, the transmitter head requires a large unit volume.

WO 92/17929 likewise describes a system for contactless energy transmission, in which the transmission path is made up of a forward line and a return line in the form of line conductors. In this case, the transmitter head implemented with an E-shaped core and a winding disposed on the middle limb of the E-shaped core likewise requires a large unit volume.

DE 197 46 919 A1 describes a flat arrangement which, however, results in low efficiency in the energy transmission.

Therefore, the object of the present invention is to further develop a system for contactless energy transmission in such a way that it requires a smaller unit volume in an inexpensive and uncomplicated manner.

According to the present invention, the objective is achieved with respect to the transmitter head by the features specified in Claim 1 or 2, and with respect to the system by the features specified in Claim 12.

Essential features of the present invention with respect to the transmitter head are that the transmitter head for a system for contactless energy transmission includes a support connected to at least one ferrite core, the ferrite core being at least partially E-shaped, and the flat winding being disposed about one limb of the E. In particular, the transmitter head is designed for an electrical energy-transmission device having a primary-conductor arrangement made of at least two primary conductors running parallel to each other and at least one secondary-winding arrangement, electromagnetically coupled thereto, which is mechanically separated from the primary-conductor arrangement and is movable in its longitudinal direction; the secondary-winding arrangement has at least one secondary coil which is in the form of a flat winding and which lies in a plane situated parallel to the plane accommodating the primary-conductor arrangement; the transmitter head includes a support connected to at least one ferrite core, the ferrite core being at least partially E-shaped, and the flat winding being provided about one limb of the E-shaped ferrite core.

In this context, it is advantageous that the transmitter head is very flat, cost-effective, and requires a small unit volume. In addition, the efficiency of the energy transmission is much higher, since the E-shaped design conducts the field lines in such a way that fewer stray fields develop, and the majority of the field lines generated by the primary lines is conducted through the ferrite core having the limbs of the E.

In one advantageous embodiment, the primary conductors are formed as line conductors, or the primary conductors are formed as flat conductors whose surface normal is perpendicular to the plane accommodating the secondary-winding arrangement. In this case, it is advantageous that high current densities are achievable, litz-wire material is useable, and therefore the skin effect is reducible.

In one advantageous development, the secondary-winding arrangement is disposed at the lower side of the floor of a vehicle. This has the advantage that a rail system is useable in the same way as a system without rails.

In one advantageous refinement, the secondary-winding arrangement is embedded in a potting compound. This offers the advantage that a high degree of protection is attainable.

In one advantageous development, the primary-conductor arrangement is disposed in stationary manner in the near-surface region of a travel path. The advantage here is that high efficiency is attainable in the energy transmission.

In one advantageous refinement, the primary-conductor arrangement and/or the secondary-conductor arrangement is/are formed at least partially of litz-wire material. The advantage here is that it is possible to reduce the skin effect.

In one advantageous embodiment, the flat winding is implemented as a conductor track on a single-layer or multilayer board. This offers the advantage that it is possible to produce the transmitter head particularly inexpensively.

In one advantageous development, the board is also fitted with electronic components. The advantage in this case is that the number of components is reducible, in particular, the number of means for electrical and/or mechanical connection is reducible.

In one advantageous refinement, the board is connected to a housing part encompassing a cooling device. In particular, the cooling device has cooling fins and/or cooling fingers. This is advantageous in that the heat is able to be transmitted from the housing part to the cooling device.

Essential features of the present invention with respect to the system for contactless energy transmission using a transmitter head as recited in at least one of the preceding claims are that two line conductors are laid in the floor with a mutual distance A, the distance of the transmitter head from the floor being between 0.05 * A and 0.2 * A. This offers the advantage that great powers are able to be transmitted, accompanied by particularly small unit volume.

Further advantages are yielded from the dependent claims.

List of Reference Numerals

1	Support
2	Ferrite cores
3	Layer of a multilayer board
4	Layer of a multilayer board
5	Layer of a multilayer board
21	Housing part
22	Cooling fins
23	Electronic components
24	Ferrite cores
25	Winding
26	Board
31	Ferrite core
32	Plastic molded part
33	Litz wire
41	Floor
42	Line conductor
43	Housing part
A,B	Distance

The present invention will now be explained in more detail with reference to figures:

Figure 1a shows a transmitter head of the present invention, an enlarged section of the left end area being shown in Figure 1b. It is flat and needs a small unit volume.

Ferrite cores 2 are mounted on and connected to support 1, using, in particular, an adhesive connection or a releasable connection such as a screw connection or the like.

Provided at ferrite cores 2 is a multilayer board having layers (3, 4, 5) which bear copper conductor tracks that take the form of flat windings, and thus are implemented on the board.

In another exemplary embodiment of the present invention, a single, planar, spiral winding is provided as a conductor track of a single-layer board, less electrical power then being transmittable, however.

In other exemplary embodiments of the present invention, particularly according to Figures 1a and 1b, a multilayer board (3, 4, 5) is used that has a spiral winding in several planes. In that case, in particular, the current conduction runs not only in a single, spiral, specific plane, but rather the conduction changes repeatedly between the planes to reduce the skin effect. That means that advantageously, after a short conductor-track section, a change is made to a next plane of the board; there, a short conductor-track section is traversed again, and then in turn a change is made. In this way, a quasi-twisted current conduction is obtained which, as far as the basic principle is concerned, corresponds to a litz wire, thus, a multiple bundle of mutually insulated current leads. The winding thus obtained is therefore quasi-twisted.

Figure 2 shows the entire structure of the transmitter head together with board 3 bearing the winding. Board 3 also bears electronic components 23 and has the necessary conductor tracks.

Board 3 and ferrite cores 4 are joined to a housing part 21 that also has cooling fins 22 for heat dissipation.

Figure 3 shows a further exemplary embodiment according to the present invention. In this case, disposed on ferrite core 31 are plastic molded parts 32, in whose depressions, litz wires 33 are embedded. The litz wires are missing in Figure 3a. In the left upper half of Figures 3 and 3a, a symbolic intersection through plastic molded parts 32 is shown, with the indication of two inserted litz wires 33. Plastic molded parts 32 facilitate the insertion of litz wires 33. Ferrite core 31 is E-shaped, and the winding is implemented about the middle limb of the E. The three limbs of the E are very short, particularly as short as the height of the winding.

Figure 4 shows the part for the inductive energy transmission of the system. Embedded in floor 41 are two line conductors 42, constructed from litz wire, which have a mutual distance A of 140 mm. In other exemplary embodiments of the present invention, values from 100 mm to 200 mm are also advantageous.

The flat transmission head, provided in a housing part 43, has a maximum distance B to floor 41 of 15 mm, thus approximately one tenth of distance A of the line conductors. Instead of a tenth, values between 7% to 12% are advantageous.

These indicated geometric features are achieved in the present invention by designing the winding to be flat. The lines of the winding lie in one plane and do not cross over each other.

In other exemplary embodiments of the present invention, plastic molded parts 32 are designed as modules able to be joined to one another, whose depressions are formed in such a way that the litz wire is either insertable into straight lines or into circular-arc pieces. To that end, both the straight and the circular-arc-type shapes are impressed as depression into the original plastic part in such a way that protuberances remain which are partially interrupted relative to each other, thus do not all directly connect together.

The transmitter head is incorporated in a vehicle or machine part (not shown in the figures) which is relatively movable with respect to the floor.

The system of the present invention for contactless energy transmission advantageously operates according to the electronic and electrical features indicated in DE 44 46 779 C2, DE 100 53 373 A1 and/or DE 197 35 624 C1, and is correspondingly designed. In contrast to these documents, however, the power transmission, especially the transmitter head, is implemented with particularly small unit volume.